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Rediscovery and expansion of the distribution of *Phyllanthus itatiaiensis* Brade (Phyllanthaceae) in southeastern Brazil

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Abstract

We report here the rediscovery of *Phyllanthus itatiaiensis* Brade (Phyllanthaceae) in Rio de Janeiro after 50 years. We also report new occurrence records of this species in Minas Gerais state, southeastern Brazil. We provide a taxonomic diagnosis, *in situ* photographs, a distribution map, and a reassessment of its conservation status, which will improve the knowledge of this rare, endemic species as well as the ability to protect it. *Phyllanthus itatiaiensis* is currently classified as Endangered under IUCN criteria B1ab(iii), B2ab(iii).

Keywords

Atlantic domain, biodiversity hotspot, endemism, *Phyllanthus* subsect. *Clausseniani*, taxonomy

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Introduction

The Atlantic Forest is considered a global biodiversity hotspot. It extends along the eastern coast of South America, with 90% of its area within Brazilian territory. Thus, it represents one of the principal phytogeographic domains in Brazil (Ribeiro et al. 2009; Colli-Silva et al. 2020; Ostroski et al. 2020). The forest retains enormous species richness and high endemism of both plant and animal taxa (Myers et al. 2000). Recent estimates indicate that the Brazilian Atlantic Forest holds approximately 15,000 native species of angiosperms, half of which are exclusive to this phytogeographic domain (BFG 2018).

In addition to being a hotspot for plant diversity, the Brazilian Atlantic Forest is also associated with a wide variety of geomorphological formations, including highland grasslands (Rizzini 1997; Pereira et al. 2020). Those mountain phytophysiognomies associated with the Atlantic Forest combine unique abiotic and biotic conditions that favor high species diversity (Segadas-Viana and Dau 1965; Rizzini 1997; Safford 1999).

The Itatiaia Massif in the Serra da Mantiqueira Range stands out among the many mountain formations found within the Atlantic Forest domain and has been the target of plant research and collection campaigns by prominent

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European and Brazilian naturalists, including Auguste de Saint-Hilaire, Ernesto Ule, Friedrich Sellow, José M. da C. Vellozo, and Per Karl Dusén (Martinelli et al. 1989; Coelho et al. 2017; Carrijo et al. 2018). Those historic expeditions, which took place in the 19th and early 20th centuries, contributed to the discovery of many plant species, as well as the development of the *Flora fluminensis* (Coelho et al. 2017; Colli-Silva et al. 2020).

Recent discoveries of new taxa (Cardoso et al. 2019; Vanderplank 2020) and biogeographic records (Santiago et al. 2018), as well as the rediscovery of numerous species (Miranda and Menini Neto 2010; Guimarães et al. 2020) in the Serra da Mantiqueira region, reinforce the view that the area comprises significant floristic richness and diversity, and needs to be further explored with floristic and phytosociological focuses (Pompeu et al. 2014).

Species of many different plant groups can be found in the Serra da Mantiqueira mountains, including *Phyllanthus* L. Fifty-four species of the genus have been recorded in the Atlantic Forest, although taxa restricted to highland grasslands in that domain have only been poorly studied and are represented by few collected specimens, such as *Phyllanthus pinifolius* Baill. and *Phyllanthus itatiaiensis* Brade (Martins et al. 2014, 2017; Orlandini et al. 2021).

Phyllanthus itatiaiensis, a taxon established by Brade (1957), was only known from the type collection. According to Martins et al. (2014), the species is endangered, and only limited information is available on its geographic distribution and conservation status. Recently, however, populations of *P. itatiaiensis* were found in Serra da Mantiqueira, in the Itatiaia National Park (INP), during the project "Rediscovering endangered species in Conservation Units (UCs) in the Atlantic Forest: bases for management, conservation and access to information". Additionally, specimens of *P. itatiaiensis* that had mistakenly been identified as *Phyllanthus niruri* L. were found among HUCS Herbarium collections. Despite relatively constant floristic studies in the type locality, this species has not been reported for more than 50 years.

We report here the rediscovery of *P. itatiaiensis*, 50 years after its last collection in the type locality, as well as a new occurrence record for Minas Gerais state in southeastern Brazil. We include a taxonomic diagnosis, *in situ* photographs, a distribution map, and a reassessment of the conservation status of *P. itatiaiensis*, which will all contribute to a better understanding of its distribution and conservation status in INP in the Serra da Mantiqueira.

Methods

Area characterization. The INP, comprises the Itatiaia massif, in the Serra da Mantiqueira, and includes municipalities in the states of Rio de Janeiro (RJ) and Minas Gerais (MG) (Moreira et al. 2020). The area has a mesothermal climate and a rugged and rocky landscape ranging from 700 to 2,787 m a.s.l. (Barreto et al. 2013). That geomorphological situation, as already mentioned, results in the establishment of different phytophysiognomies, depending on the elevation (Segadas-Vianna and Dau 1965; Geise et al. 2004).

Sampling and data treatment. The present study was based on the study of collections held in the F, HUEFS, MBM, MG, NY, RB, SP, and HUCS herbaria (acronyms according to Thiers 2021), consultations of the specialized literature (Brade 1957; Webster 2002; Martins et al. 2014), and field expeditions carried out between October and December/2019 in INP in the municipalities of Resende (RJ) and Itamonte (MG). The specimens observed in the field were photographed using a digital camera (Nikon Coolpix P500) and collected following Fidalgo and Bononi (1989). Field specimens were deposited in the RB herbarium.

The species' conservation status was determined following IUCN (2012) criteria and the use of the Geocat tool (http://geocat.kew.org; Bachman et al. 2011). The distribution map was prepared using Quantum GIS v. 2.8.2 (Quantum GIS development team 2018).

Results

Phyllanthus itatiaiensis Brade

Figure 1C–F

New records (Fig. 2). BRAZIL • Minas Gerais, Itamonte; 22°21′37″S, 044°40′07″W; 16 Dec. 2019; fl., fr.; J. Külkamp et al. 1117 (RB 01426341) • Rio de Janeiro state, Itatiaia; 13 March 2010; fr. J.M. Silva 7550 (HUCS 36267). • Rio de Janeiro state, Resende; 22°22′27″S, 044°40′22″W; 31 Oct. 2019; fl., fr. C. Baez & A. Sá 1780 (RB 01423645) • Rio de Janeiro state, Resende; 22°22′28″S, 044°40′33″W; 3 Nov. 2019; fl., fr.; C. Baez & A. Sá 1800 (RB 01423665).

Additional material examined. BRAZIL • Rio de Janeiro state, Itatiaia; Mar. 1937; fl. A.C. Brade 15575 (RB 00569788, holotype) • Rio de Janeiro state, Itatiaia; May 1950; fl. A.C. Brade 20362 (RB 00545529, paratype).

Identification. *Phyllanthus itatiaiensis* can be distinguished from other species of the genus by having oblong to falcate leaves, and stipules 1–1.5 mm long, triangular-lanceolate, showy, and pink. It resembles *P. niruri* L. in terms of their shared herbaceous habits, as well as by having staminate and pistillate flowers with five sepals, and the androecium formed by three stamens with free filaments; it differs from *P. niruri* by having oblong to falcate leaves with slightly revolute margins (vs. oblong leaves with flat margins in *P. niruri*), stipules 1–1.5 mm long, triangular-lanceolate, showy, pink (vs. 0.5–1 mm long, linear to lanceolate, not showy, greenish), and the pedicels of the male flowers 1–2 mm long. (vs. 2.5–4 mm long).

Habitat and distribution. *Phyllanthus itatiaiensis* is

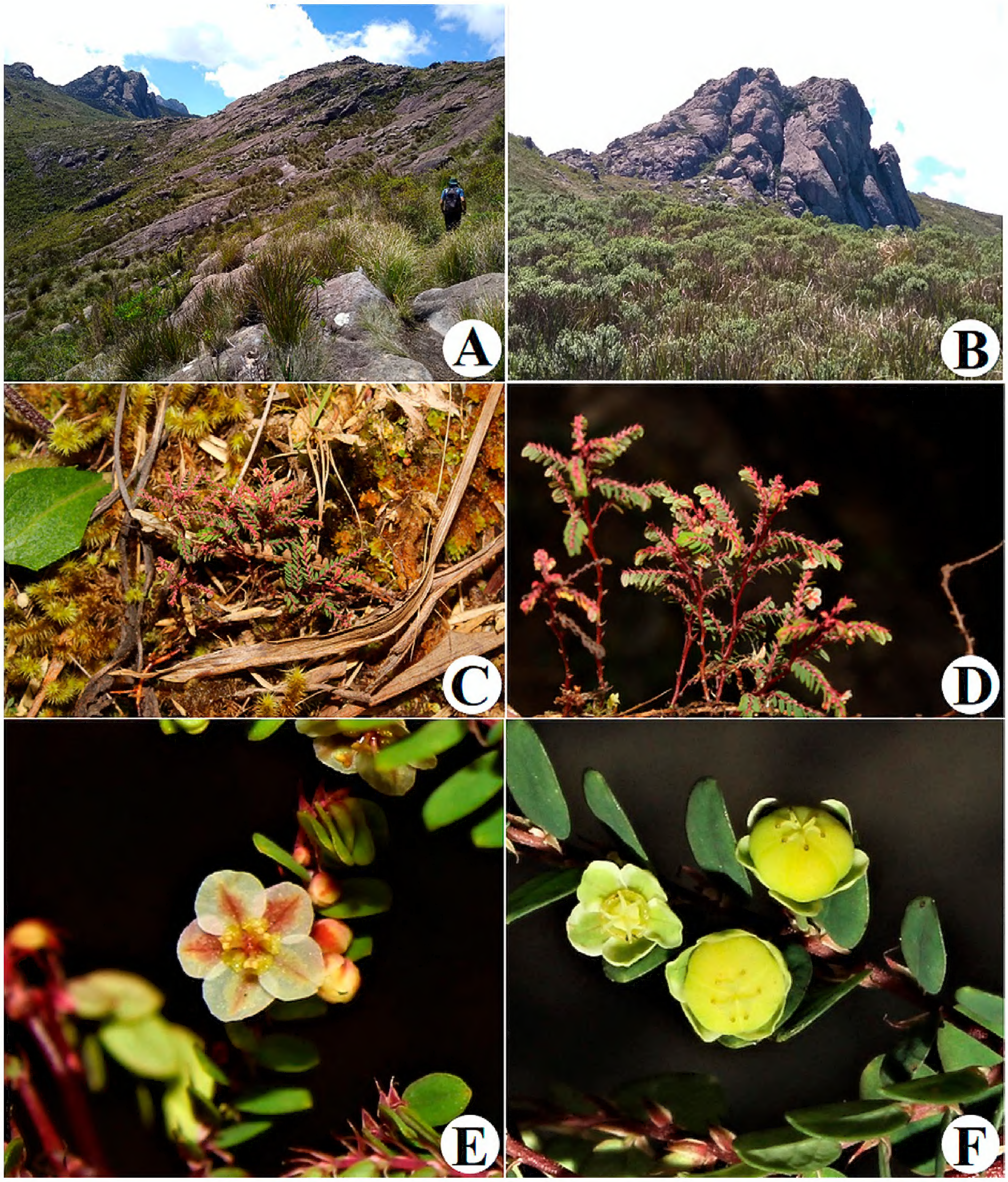

Figure 1. *Phyllanthus itatiaiensis*. **A, B.** Habitat, with emphasis on the Pedra do Altar rock formation. **C, D.** Habitat. **E.** Staminate flower. **F.** Pistillate flower and fruits. Photographs: Caio Baez (A, B); J. Külkamp (C–F).

endemic to Brazil, with its distribution restricted to the Atlantic Forest in the southeastern region of the country. It is endemic to highland grasslands on the Itatiaia Massif, in the municipalities of Itatiaia and Resende (RJ) and Itamonte (MG) (Figs. 1A, B, 2). The species is often found in wetlands and along lakesides where it is associated with *Chusquea pinifolia* Nées (Poaceae) (Martins et al. 2014).

Phenology. Flowering and fruiting between March and December.

Conservation status. The species is classified as Endangered under criteria B1ab(iii), B2ab(iii) (IUCN 2012). The area of occupation is 80.5 km^2 and the extent of occurrence is 164.9 km^2. The main threats to *P. itatiaiensis* are related to intense losses of areas of occupation as well as habitat quality degradation, the latter due to constant forest fires and tourism in the INP.

Comments. Following the classification proposed by Webster (2002), *P. itatiaiensis* was circumscribed under *P.* subsect. *Clausseniani* Webster for having stamens

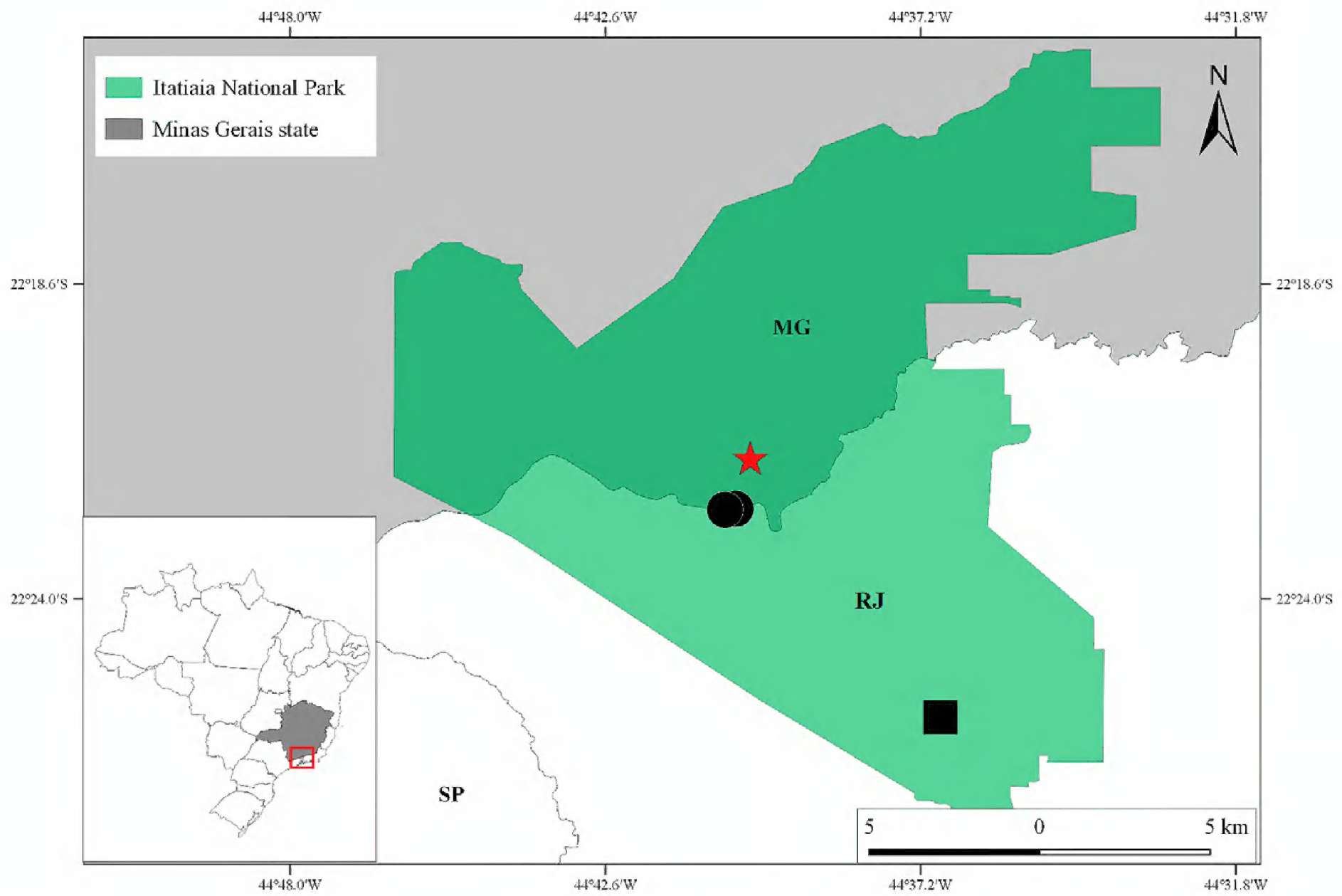

Figure 2. Distribution of *Phyllanthus itatiaiensis* in Brazil. New record from Rio de Janeiro state (circles) and Minas Gerais (star); the type collection (square).

with free filaments, anthers deeply emarginated, and a distinct theca. The species is morphologically related to *P. mocotensis* G.L Webster and *P. carvalhoi* G.L Webster, but can be distinguished from the former because it is an herb with typically phyllanthoid branches (vs. subshrub, with rigid branches with fissures), and from the latter by having oblong leaves, rarely falcate (vs. falcate-asymmetrical). From a phylogenetic point of view, until now, the studies carried out (Samuel et al. 2005; Kathriarachchi et al. 2006; Bouman et al. 2020, Hidalgo et al. 2020) have not included *P. itatiaiensis*. For this reason, one of us (J.C.R. Mendes) is conducting molecular phylogenetic analyses of the species of the subsection *Clausseniani*.

Discussion

Although specimens of *Phyllanthus itatiaiensis* were collected in highland grasslands within a protected area (the INP), those grasslands have undergone both natural and anthropic threats to the species (Assis and Matos 2016; Gonçalves and Santos 2018). Among the anthropic threats are fires and unregulated tourism, while changes in environmental conditions reflect intensifying climate change (Aximoff and Rodrigues 2011; Assis and Matos 2016). The INP experiences major fires almost every year, as well as increasing tourism throughout its extent (Lima 2000; Aximoff and Rodrigues 2011). To avoid or mitigate losses in biodiversity, it will be important to establish proactive environmental actions and policies within this and other conservation areas in the Atlantic Forest—and especially in highland grasslands—focusing on stricter enforcement and the implementation of measures to prevent and combat fires and other threats. Additionally, although many recent studies have focused on cataloging the richness of the INP flora (e.g., Morim and Barroso 2007; Giannerini et al. 2007, 2015; Barberena et al. 2008; Pereira and Mansano 2008; Monteiro and Guimarães 2009; Barros et al. 2010; Ramos and Sylvestre 2010; Mezabarba et al. 2013; Rollim and Trovó 2016; Freitas and Trovó 2017; Gonzaga et al. 2017), additional floristic surveys will be necessary for searching for *Phyllanthus* species in highland grasslands.

Many species of the genus have been recorded in the Serra da Mantiqueira region, and some of them are endemic (e.g., *P. acutifolius* Poir. ex Spreng. and *Phyllanthus pinifolius*). Field expeditions in little- or unexplored areas of highland grasslands may reveal new occurrence records, new species, or even new populations of *P. itatiaiensis*, which would contribute to the conservation of this species and other rare and endemic species in the Brazilian Atlantic Forest.

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Authors' Contributions

CBG collected the specimen and identified the specimen, JCRM designed the study and wrote the manuscript; AMT contributed to the writing of the manuscript; SMAS contributed to the discussion and review; RTMR contributed to the writing, reading, review, and correction of the manuscript; MFS contributed to the correction and research funding; TTC contributed to the correction of the manuscript and research funding.

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